

# Utilization of Solid Waste of Tofu and Out of Grade Carrot as a Source of Vegetable Protein and Fibre in Nugget Processing

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**Abstract**— Tofu residue production is a solid by-product of the tofu industry, which contains high protein and can be processed for food consumption. It has a good taste and is safe to consume as a chicken meat substitute in the form of nuggets they are called de-soya nuggets. One of the methods to decrease bad health effects from fast food is to use tofu nuggets made from the Tofu waste by fortification with local food ingredients that are rich in fiber and antioxidants, similar with out-of-grade carrot. From the research it can be concluded that the substitution of tofu waste and carrot fortifications as de-soya nuggets can increase the nutritional value and fiber of food. Nuggets known as fast foods have high amounts of fat and cholesterols because they are made from animal fat and have low amount fiber. The number of nutritional values that fulfill the standard for a de-soya nugget is, with the largest substitute being of 30% tofu waste with carrot fortifications of 15% that contains 12.53% protein, 30.1% carbohydrate, 11.83% fat, 42.8% water, 1.8700% ash, 8.05% dietary fiber, and less than  $3.0 \times 10^3$  ( $1.8 \times 10^3$ ) colonies/gr total microbial.

**Keywords**— Tofu waste;tofu residue; out-of-grade carrot; nugget; dietary fiber

## I. INTRODUCTION

Tofu waste is industrial solid waste of tofu. During this time tofu waste is not fully utilized. Tofu is more widely used as cattle feed (cows and pigs) or thrown away. Whereas tofu has a high nutritional content, i.e. 23.55% of protein, fat 5.54%, 26.92% carbohydrate, 17.03% ash, 16.53% crude fibre, and 10.43% water.

This high protein contents and can be processed into a food which delicious and safe to be consumed. Tofu waste can be used as a substitute in the manufacture of chicken nuggets, with the purpose not just as an effort to reduce pollution from waste of tofu, but also capable of providing nutrition as an alternative source of protein and fibre (dietary fibre) that would benefit the human body. Another benefit is to be able to reduce nugget manufacturing costs, without compromising the distinctiveness flavor of nuggets. One way to improve the health effects of fast food such as tofu nuggets with this substitution is local foodstuffs fortified with fibre-rich and antioxidants such as carrots.

Carrots is one of the vegetables with fibre content (total of 46.95% dry weight) consisting of soluble dietary fibre content of 5.66% dry weight, and insoluble dietary fibre content of 41.29% dry weight, so carrots can be used as a source of dietary fibre” [1],[16].

Based on the fact above, we need to study the utilization of tofu solid waste and out-of-grade as a source of protein and fibre in a nugget (fast food). The purpose of this study is to determine the optimum level of substitution of chicken meat with tofu and fortified from out-of-grade carrot for the manufacture of de soya nuggets, and also to determine the nutritional value and chemical composition of the nuggets de soya.

## II. RESEARCH METHOD

The research was carried out using a completely randomized design (CRD) consisting of nine treatment and three replications. The treatment were the substitution solid waste tofu (A1= 20%, A2=30%, A3=40%) and the fortification of out-of-grade carrot (B1=5%, B2=10%, B3=15%) into the nuggets formulas, thus A1B1, A1B2, A1B3 ,A2B1 ,A2B2, A2B3 , A3B1, A3B2, and A3B3.

The variables observed were protein, fat, carbohydrate, water, ash, dietary fiber, and total microbial content of nuggets. Sensory evaluation (Taste, aroma, texture and overall acceptance) of nuggets were analyzed by hedonik test. The variable observation includes the test whether the F calculated is greater than or equal to the F in the table and followed by analysis DNMRT test with a significant level of 5% with the method of SPSS System.

### III. RESULTS AND DISCUSSION

#### A. Protein, fat, carbohydrate, moisture and ash content

Substitution and fortification on the making of tofu waste nuggets provide a significant influence on protein, fat, carbohydrate, water, and ash content of the nugget de soya, whereas water content did not give a real difference. For more details can be seen in Figure 1, 2, 3, and 4.

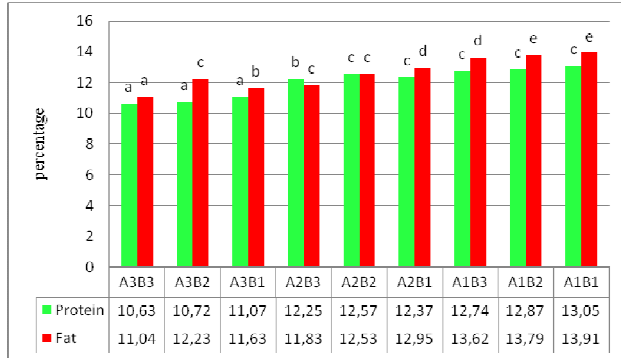


Fig. 1 Average content of protein and fat content with different nugget de soya tofu substitution percentage and fortified carrot "out of grade"

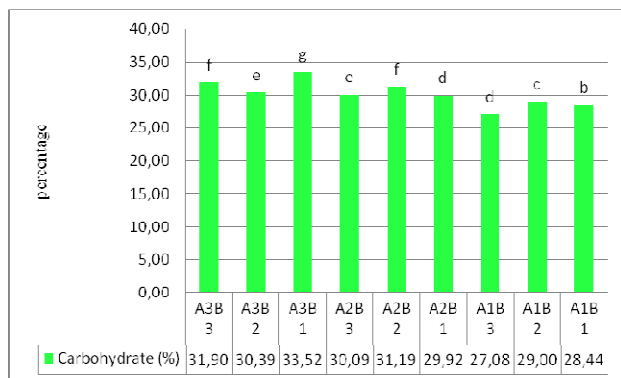


Fig. 2 Figure 1 Average content of carbohydrate content with different nugget de soya tofu substitution percentage and fortified carrot "out of grade"

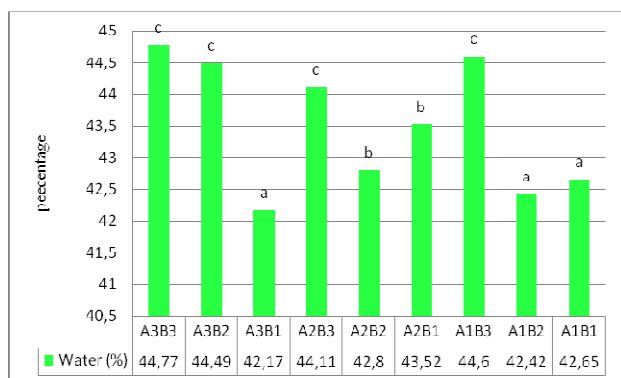


Fig. 3 Average content of water content with different nugget de soya tofu substitution percentage and fortified carrot "out of grade"

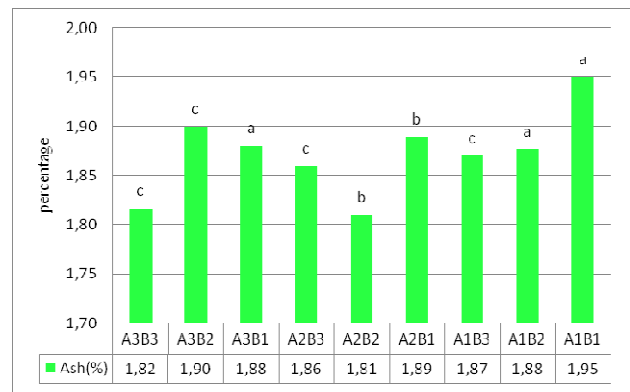


Fig. 4 Average content of ash content with different nugget de soya tofu substitution percentage and fortified carrot "out of grade"

Average treatment marked the same lowercase letter are not significantly different at 5% level based on DNMRT test.

Substitution process on fortified tofu and out-of-grade carrots affect the protein content of de soya nuggets. The substitution process of tofu decreases the protein content; protein content was found the lowest at 40% substitution process of tofu with 15% out-of-grade carrot fortified, and protein content of 10.63%.

Compared with the chicken nuggets were in the market, chicken nuggets with a trademark 'Fiesta' net has a protein content of 250 grams or 11%, while the chicken nuggets with a trademark of 'So Good' has 400 grams or 12% protein content.

The higher the level of fortification substitution process of tofu and out-of-grade carrots the lower the fat content, this is caused by the tofu and carrots have a lower fat content than chicken meat. Fat content in 'Fiesta' nuggets nets to 250 grams or 25% (PT. Charoen Pokphand Indonesia, 2009).

Lipid content in the 'Fiesta' nuggets derived from chicken fat which contains cholesterol, while in the de soya nuggets of chicken meat as well as also from the coconut milk. Vegetable fats contain no cholesterol. According to [12], "chicken meat contain 60mg/100 g cholesterol Added by James Anderson (2008) consumption of soya products can reduce low-density lipoprotein (LDL) is known as bad cholesterol, and helps strengthen the heart."

Carbohydrate content of the nugget is strongly influenced by the natural high given amount in the tofu waste itself. "Carbohydrate content of tofu is 26.92%; carbohydrate content of the nugget was generated far higher than the levels of carbohydrate nuggets that circulated in the market" [3].

Water content in nuggets from various levels of substitution of tofu given water content and fortification levels ranged from 42.17 to 44.78%. Nugget pertained to the semi-moist foods that have moisture content between 40-60%.

Ash content in the nuggets with various formulations substitutes of tofu and fortified carrot "out off grade" were not significantly different, means minerals contained by each nugget is relatively the same formulation.

#### B. Fibre Concentration test (Dietary fiber)

De soya nuggets fiber content increased along with the occurrence of elevated levels of fortification substitution

process of tofu and carrots 'out off grades', which is the largest component of fiber found in plant cell wall structures such as cellulose, hemicelluloses, and lignin and substance *pectates*. The more substitutes of tofu and fortified carrot nuggets added to the higher fiber content of the material.

TABLE 1  
TOTAL FIBRE CONTENT 'FIESTA' NUGGETS AND NUGGETS DE SOYA

No.	Treatment	Dietary fiber (%)
1.	'Fiesta'	3.0000
2.	A1B3	6.5240
3.	A2B3	8.0458
4.	A3B3	9.4237

"Has been widely known that the benefits of dietary fiber in the body can bind water so stools become soft, can reduce levels of blood cholesterol by binding bile acids, is able to speed up transit time, and can bind carcinogenic substances" [10]. Dietary fibre is a component in plant that is not digested enzymatically into sections which can be absorbed in the digestive tract. Fibre naturally present in plants composed of various substances that most of them are complex carbohydrates.

According to [8], "dietary fibre will absorb moisture and produce viscous gel in the digestive process that slow the emptying process of stomach and food transit. Dietary fibre also protects carbohydrate from digestive enzymes and slow glucose absorption. Dietary fibre was divided into two groups, i.e. soluble and insoluble fibre. Generally, plants containing both the fibre do not dissolve in the higher portion. Soluble fibres consist of pectin, gum from plant, and some hemicelluloses. Examples of insoluble fibre are lignin and cellulose. Dietary fibre components in plants that are not digested *enzymatically* into sections can be absorbed in the digestive tract. Fibre naturally present in plants. "Fibre composed of various substances that most of them are complex carbohydrates" [9]. "Dietary fibre also decreases the glucose and insulin level for diabetes patients, and lower the chance to be exposed to" [7].

### C. Total Microbe Test

Total microbial treatment substitutes tofu for 40% and 10% TBUD fortified carrots (not to be counted in  $10^5$  dilutions). While for the tofu substitution treatment 20% and 30%, which is fortified carrots 5%, 10% and 15% and 40% substitution of tofu and fortified 5% and 15% gave a small amount of the 30 colonies on the dilution of  $10^3$  and  $10^4$ . The more variety of additional materials used for processing the greater the chance for product contamination. Overall treatment combinations for total micro-organisms are below the standard threshold for wet food that has been determined by *Indonesia Government Council for Drug and Food (BPOM)* of  $10^6$  colonies / gr. For more details can be found in Table 2.

### D. Sensory Evaluation

Sensory evaluation (taste, aroma, texture and appearance) of nuggets for each type of nugget can be accepted by consumers and for each treatment was not significantly different. For more details can be found in Table 2. Nugget of flavor and aroma are not affected by the concentration difference tofu, tofu given for no longer having a distinctive

flavor and aroma because it has undergone a process of soaking, and heating, and the remaining tofu extraction process. The range for the flavor and aroma successively participated: 3.3000 - 3700, and 3.2000 - 3.3533. Texture nugget produced was not significantly different from each other because of tofu and carrots that are given have a similar texture to the texture of chicken meat. The range for texture is 3.2667 - 3.3533. While the appearance of the nugget produced was not influenced by the level of fortification carrot "out off grade", the range of weeks to the appearance of the nugget is as follows 3.1200 - 3.4167.

TABLE 2  
AVERAGE TOTAL MICROBIAL DE SOYA NUGGETS WITH A DIFFERENCE PERCENTAGE SUBSTITUTION AND FORTIFIED TOFU WASTE AND OUT-OF-GRADE CARROTS (COLONIES/G)

Treatment	Total Mikrobial (colonies/gr)
A1B1	$<3.0 \times 10^3$ ( $2.0 \times 10^3$ )
A1B2	$<3.0 \times 10^3$ ( $1.5 \times 10^3$ )
A1B3	$<3.0 \times 10^4$ ( $1.2 \times 10^4$ )
A2B1	$<3.0 \times 10^3$ ( $2.7 \times 10^3$ )
A2B2	$<3.0 \times 10^3$ ( $2.2 \times 10^3$ )
A2B3	$<3.0 \times 10^3$ ( $1.8 \times 10^4$ )
A3B1	$<3.0 \times 10^3$ ( $9 \times 10^3$ )
A3B2	TBUD
A3B3	$<3.0 \times 10^3$ ( $2.7 \times 10^5$ )

### E. Analysis of Daily Intake

Based on the results of the proximate analysis, the dietary fiber test, the total microbial test, and *organoleptic* test, it turns out that the best percentage of substitution of tofu and fortified out-of-grade carrot that meet the standards is the A2B3 treatment (30% substitution of tofu and fortified carrots 15%). Analysis of the nutritional adequacy for the average treatment A2B3 can be seen in Table 3.

TABLE 3  
NUTRITION CONTENT OF DE-SOYA NUGGETS TO 100G (PER SERVING) IN THE DIET

No	Nutritional	Value	Percentage RDI		
			'De-soya'	'Fiesta'	'So-good'
1	Energy	282,69 kcal	14,1%	17,5%	11%
2	Protein	12.25 gr	24,5 %	18%	20%
3	Carbohydrate	30.09 gr	10%	6%	4%
4	Fat	11,83 gr	21,3%	40%	20%

From Table 3, it can be seen that the energy percentage of RDI for calories in De-soya nuggets relatively higher than the 'So Good' with 14.1% and 11.5% but it is lower than the 'Fiesta' nuggets. But unlike the amount of energy produced, De-Soya nuggets proved to contain the most protein out of 3 contenders, with the value of 24.5%, while Fiesta and So Good nuggets sit on 18% and 20% consecutively. Similar with the amount of protein, 'De-Soya' nuggets also produced the most carbohydrate with 10%, while 'Fiesta' and 'So-Good' nuggets in 6% and 4% consecutively. The fact that De-Soya nuggets contain more carbohydrate is because tofu as the main ingredient in this type of nuggets

contain more carbohydrate than the raw ingredient used in the making of 'Fiesta' and 'So Good' nuggets. Meanwhile, different with protein and carbohydrate contained in 'De Soya' nuggets, fat content in 'De Soya' nuggets is relatively, proven to be only half of 'Fiesta' nuggets fat content.

According to [3] "fat content of tofu is 5.54% while prepared foods like nuggets referred to as junk food because usually rich in fat and has very low fiber content. Therefore, efforts to improve the nutritional status need to be considered

#### IV. CONCLUSIONS

The research proves that the tofu waste substitution and out-of-grade carrots fortifications affect the protein content in the nuggets made, with the highest protein content found in compliance with the standard treatment of 30% tofu waste substitution and 15% out-of-grade carrot fortification.

Substitution of tofu waste and fortified out-of-grade carrots provide the increase in the total of dietary fiber. The highest total dietary fibre was 9.42% found at the substitution process of 40% tofu waste, and the fortification of 15% out-of-grade carrots.

The nutritional adequacy rate of nugget 'De Soya' with the best possible content found in compliance with the standard treatment of 30% tofu waste substitution and 15% out-of-grade carrot fortification, with 2000 calories diet; it produces 14.1 calories energy, 24.5% protein, 10% carbohydrate, 21.3 fat and 8.05% dietary fibre.

#### V. SUGGESTIONS

Waste tofu can provide nutrition as an alternative source of protein and dietary fibre. It can be utilized in the manufacture of nuggets that provide economic value, as it also can be fortified with out-of grade carrots to increase the fiber content of food. Nugget is known as a food product contains high fat and cholesterol, but with substitution and fortification process, the levels of fat/ cholesterol can be reduced so that the image of junk food can be erased.

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